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ASSIGNMENT BOOKLET
SCN3260 Physics 30
Module 2 Assignment

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Physics 30

Learn EveryWare

we explore

The Conservation of Momentum in Isolated Systems

Module 2

Assignment Booklet

Red Deer Catholic Regional Schools
Edmonton Public Schools
Calgary Board of Education
Alberta Education

FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Lesson 1 Assignment	24	
Lesson 2 Assignment	22	
Lesson 3 Assignment	24	
Project	11	

Teacher's Comments

Physics 30
Module 2: The Conservation of Momentum in Isolated Systems
Assignment Booklet
ISBN 978-0-7741-3200-8

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MODULE 2: LESSON 1 ASSIGNMENT

This Module 2: Lesson 1 Assignment is worth 24 marks. The value of each assignment and each question is stated in the left margin.

(24 Marks) Lesson 1 Assignment: Linear Collisions and the Conservation of Momentum

(2 marks) **LAB 1.** a. Is there a relationship between the change in velocity of the blue mass and the green mass? If yes, describe the relationship.

____

____

____

(2 marks) b. Is there a relationship between the change in momentums of the blue mass and the green mass? If yes, describe the relationship.

____

____

____

(2 marks) **LAB 2.** If the change in momentum of one object is exactly equal but opposite to the change in momentum of another object, what does that indicate about the total momentum of the system?

____

____

____

(5 marks) **LAB 3.** If the total momentum of a system before a collision is equal to the total momentum of a system after a collision, then momentum is conserved. For each of the five collisions, verify that the total initial momentum is equal to the total final momentum by completing the following table.

Notice the following shorthand way of talking about the sum of the momentums of the blue and green masses. The capital Greek letter sigma (Σ) is often used to denote sums.

$$\sum \vec{P}_{\text{initial}} = \vec{P}_{\text{initial green ball}} + \vec{P}_{\text{initial blue ball}}$$

$$\sum \vec{P}_{\text{final}} = \vec{P}_{\text{final green ball}} + \vec{P}_{\text{final blue ball}}$$

Collision	Total Initial Momentum $\sum \vec{P}_{\text{initial}}$ (kg·m/s)	Total Final Momentum $\sum \vec{P}_{\text{final}}$ (kg·m/s)	Is Momentum Conserved? $\sum \vec{P}_{\text{initial}} = \sum \vec{P}_{\text{final}}$
1			
2			
3			
4			
5			

(3 marks) **A 1.** Object A, with a mass of 2.0 kg, is travelling to the right at 15.0 m/s. Object B, with a mass of 12.5 kg, is also travelling at 15.0 m/s, but to the left. If the two objects stick together upon impact, what is the final velocity of the system?

(3 marks) **A 2.** A 250-g firecracker explodes into two pieces. The first piece has a mass of 97 g and flies off to the right at 16 m/s. What is the velocity of the second piece?

(1 mark) **A 3.** Are the following collisions possible? Explain why or why not.

a. Object A, initially travelling to the right, collides with object B, which is at rest. After the collision, object A moves back to the left and object B remains at rest.

____

____

____

(1 mark) b. Object A, initially travelling to the right, collides with object B, which is at rest. Object B has more mass than object A. After the collision, object A moves back to the left and object B moves to the right.

____

____

____

(1 mark) c. An object is travelling to the right and collides with another object that is at rest. After the collision, both objects travel to the right, but at different speeds.

____

____

____

D 4. In answering this question you have made some assumptions. Knowing this, would those assumptions be grounds for reasonable doubt if there was a court case against the car's driver due to damages caused by the collision? Post your answer to the discussion forum and read the other students' postings.

(4 marks) **D 5.** Read the other students' comments and then rewrite your own answer to D4. Include a description of what you learned from the other students' responses.

MODULE 2: LESSON 2 ASSIGNMENT

This Module 2: Lesson 2 Assignment is worth 22 marks. The value of each assignment and each question is stated in the left margin.

(22 Marks) Lesson 2 Assignment: Kinetic Energy and Collisions

(5 marks) **LAB 1.** In the following chart, record the initial velocity and final velocity for each object. Calculate the initial and final momentum and energy for each object using the mass and velocity values.

Do not worry about what e represents—this will be discussed in detail in the next section. The value of e will be listed with the other information on the simulation and must be recorded for each collision.

Collision 1 e = ____

Object	Mass (kg)	$\vec{V}_{\text{initial}}$ (m/s)	$\vec{V}_{\text{final}}$ (m/s)	$\vec{P}_{\text{initial}}$ (kg·m/s)	$\vec{P}_{\text{final}}$ (kg·m/s)	E_k initial (J)	E_k initial (J)
blue	5.0						
green	5.0						
total	_____	_____	____				

Collision 2 e = ____

Object	Mass (kg)	$\vec{V}_{\text{initial}}$ (m/s)	$\vec{V}_{\text{final}}$ (m/s)	$\vec{P}_{\text{initial}}$ (kg·m/s)	$\vec{P}_{\text{final}}$ (kg·m/s)	E_k initial (J)	E_k initial (J)
blue	5.0						
green	5.0						
total	_____	_____	____				

Collision 3 e = ____

Object	Mass (kg)	$\vec{V}_{\text{initial}}$ (m/s)	$\vec{V}_{\text{final}}$ (m/s)	$\vec{P}_{\text{initial}}$ (kg·m/s)	$\vec{P}_{\text{final}}$ (kg·m/s)	E_k initial (J)	E_k initial (J)
blue	5.0						
green	5.0						
total	_____	_____	____				

Collision 4 e = ____

Object	Mass (kg)	$\vec{V}_{\text{initial}}$ (m/s)	$\vec{V}_{\text{final}}$ (m/s)	$\vec{P}_{\text{initial}}$ (kg·m/s)	$\vec{P}_{\text{final}}$ (kg·m/s)	E_k initial (J)	E_k initial (J)
blue	5.0						
green	5.0						
total	_____	_____	____				

Collision 5 e = ____

Object	Mass (kg)	$\vec{V}_{\text{initial}}$ (m/s)	$\vec{V}_{\text{final}}$ (m/s)	$\vec{P}_{\text{initial}}$ (kg·m/s)	$\vec{P}_{\text{final}}$ (kg·m/s)	E_k initial (J)	E_k initial (J)
blue	5.0						
green	5.0						
total	_____	_____	____				

(1 mark) a. Is there a relationship between the changes in velocity of the blue mass and the green mass? If yes, describe the relationship.

LAB 2. Answer the following questions using the data collected in the collision tables.

(2 marks) a. Is momentum conserved in each collision?

(2 marks) b. Is kinetic energy conserved in each collision?

A 1. Complete the data table below by doing the following.

(5 marks) a. Record the total E_k initial, total E_k total and e for each collision from the lab data tables.

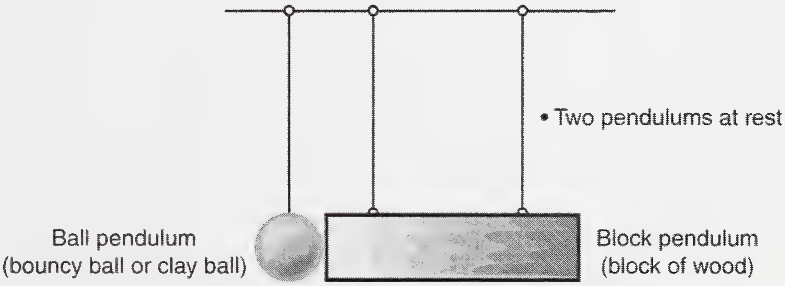
b. Calculate the percentage of loss in kinetic energy for each collision using:

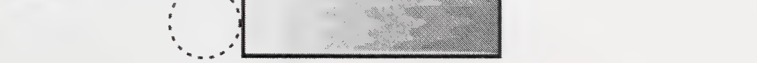
Collision	e	Total E_k Initial (J)	Total E_k Final (J)	Loss in E_k (%)
1				
2				
3				
4				
5				

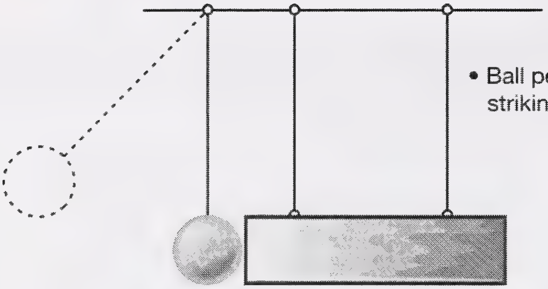
(2 marks) **A 2.** Using the same data table above, compare the percentage of total kinetic energy lost during each collision to the value of e. What is the relationship between percentage of loss in kinetic energy and e?

(5 marks) **A 3.** Design an experiment that would let you answer the following problem: is the collision between a ball pendulum and a block pendulum elastic, inelastic, or completely inelastic?

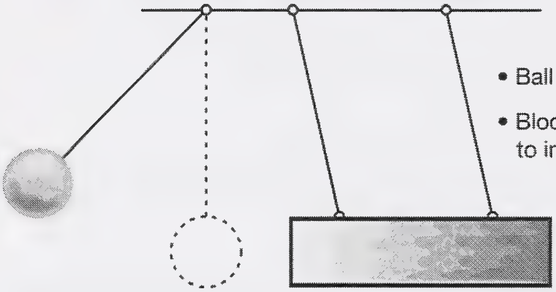
The following four diagrams give you a starting point for your experiment.







- Ball pendulum is released, striking block pendulum



- Ball pendulum rebounds
- Block pendulum responds to impact

MODULE 2: LESSON 3 ASSIGNMENT

This Module 2: Lesson 3 Assignment is worth 24 marks. The value of each assignment and each question is stated in the left margin.

Lesson 3 Assignment: Analyzing Non-Linear Collisions

(5 marks) **A 1.** A car with a mass of 1400 kg is westbound at 50 km/h. It collides at an intersection with a northbound truck having a mass of 2000 kg and travelling at 40 km/h. What is the initial common velocity of the car and truck immediately after the collision if they have an inelastic collision?

(5 marks) **A 2.** A police car with a mass of 1460 kg is headed west at 60 km/h when it has an inelastic collision with a southbound 2000-kg ambulance. The wreckage ended up travelling at 45 km/h at 236°. What was the initial speed of the ambulance?

(7 marks) **A 3.** A billiard cue ball with a mass of 0.60 kg and an eight ball with a mass of 0.55 kg are rolled toward each other. The cue ball has a velocity of 3.0 m/s at 360°, and the eight ball has a velocity of 2.0 m/s at 90°. After the collision, the cue ball moves off at a velocity of 2.0 m/s at 40°.

a. What is the velocity of the eight ball?

b. Prove whether or not the collision is elastic.

(7 marks) **A 4.** A proton with an initial velocity of 2800 m/s [90°] is struck by a neutron heading at 320° with a speed of 2900 m/s. The neutron bounces off of the proton with a velocity of 1864 m/s [270°].

a. What is the final velocity of the proton?

b. Prove whether or not the collision is elastic.

MODULE 2—THE CONSERVATION OF MOMENTUM

Project: Case File

This Module 2 Project is worth 11 marks. The value of each assignment and each question is stated in the left margin.

Throughout this module you will work on the analysis of the collision between Kathy Johnson and Bill Peterman described in the Big Picture section. Parts of the project can be solved in each lesson. As you complete each lesson add to your analysis of the collision.

Lesson 1

The mass of the truck is 3200 kg, and the mass of the car is 2800 kg. Based on the length of the skid marks at the scene and the mass of the vehicles, police estimate that the combined mass was moving at 7.0 m/s just after impact. From this point, the two vehicles slid and came to rest at the corner of the intersection.

- Determine the magnitude of the momentum just after the collision. (Analytic)
- Is this the same as the magnitude of the momentum just before the collision? Explain why or why not. (Holistic)

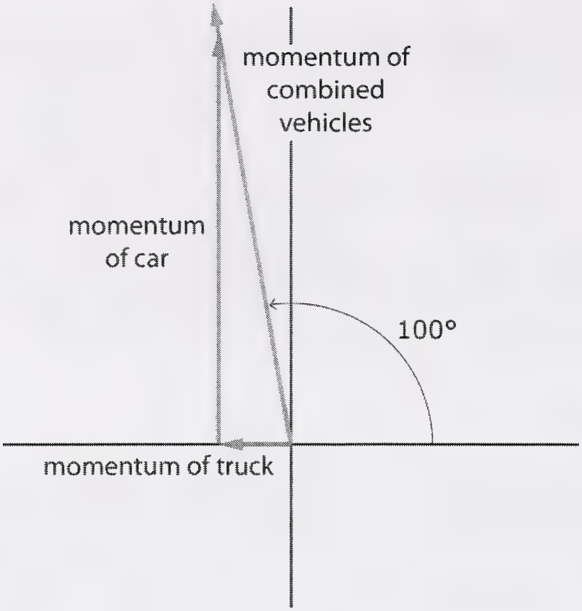
Lesson 2

Using the principle of conservation of momentum, the police determined that Bill's truck was travelling at 2.3 m/s before the collision, and Kathy's car was travelling at 15 m/s before the collision.

- What is the kinetic energy of the vehicles before and after the collision? (Analytic)
- Is kinetic energy conserved? If kinetic energy is not conserved, what does this tell us about the type of collision? (Holistic)

Lesson 3

The two momentum vectors before the collisions are represented in blue. The momentum after the collision is in red. Adding the two momentum vectors before the collision equals the momentum after the collision, according to the law of conservation of momentum.



While the photo suggests a much more complex collision than the given diagram, assume that the diagram shows exactly what happened.

- Using this vector diagram and your calculated value for the momentum of the combined vehicles, verify the police calculations and determine the momentum and velocity of Bill's truck just before the collision. (Analytic)
- Using this vector diagram and your calculated value for the momentum of the combined vehicles, verify the police calculations and determine the momentum and velocity of Kathy's car just before the collision. (Analytic)
- Does your analysis prove, beyond a reasonable doubt, that Kathy was, in fact, travelling at the speed limit of 50 km/h just prior to the accident? What assumptions did you make in your solution to determine this? (Holistic)

(6 marks) **Analytic Answer**

- Determine the magnitude of the momentum just after the collision.

- What is the kinetic energy of the vehicles before and after the collision?

- Using this vector diagram and your calculated value for the momentum of the combined vehicles, verify the police calculations and determine the momentum and velocity of Bill's truck just before the collision.

- Using this vector diagram and your calculated value for the momentum of the combined vehicles, verify the police calculations and determine the momentum and velocity of Kathy's car just before the collision.

(5 marks) **Holistic Answer**

- Is this the same as the magnitude of the momentum just before the collision? Explain why or why not.

- Is kinetic energy conserved? If kinetic energy is not conserved, what does this tell us about the type of collision?

- Does your analysis prove, beyond a reasonable doubt, that Kathy was, in fact, travelling at the speed limit of 50 km/h just prior to the accident? What assumptions did you make in your solution to determine this?

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